

# MONTHLY WEATHER REVIEW.

VOL. XX.

WASHINGTON, D. C., JULY, 1892.

No. 7.

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## INTRODUCTION.

This REVIEW is based on reports for July, 1892, from 2,900 regular and voluntary observers. These reports are classified as follows: 166 reports from Weather Bureau stations; 47 reports from United States Army post surgeons; 1,916 monthly reports from state weather service and voluntary observers; 217 reports through the Central Pacific Railway Company;

523 marine reports through the co-operation of the Hydrographic Office, Navy Department; 31 reports from Canadian stations; marine reports through the "New York Herald Weather Service;" monthly reports from local weather services established in all states and territories; and international simultaneous observations. Trustworthy newspaper extracts and special reports have also been used.

## CHARACTERISTICS OF THE WEATHER FOR JULY, 1892.

The period of persistent and exceptionally high temperature during the second and third decades was a notable feature of the month. From the 18th to the 24th the daily maximum temperature in Kansas and Nebraska was 100° or above. In the Atlantic coast and Southern States the period of greatest heat extended from the 24th to the 28th. At Philadelphia, Pa., a maximum temperature of 101° was recorded on the 26th, and 99° was the maximum reading at Baltimore, Md., and Washington, D. C. On the 27th the temperature reached 100° at Lynchburg, Va. These temperatures were the highest ever recorded at the respective stations for the third decade of July. In the east Gulf states excessive rainfall damaged crops, while in parts of New England, the Ohio Valley, and the interior of Texas vegetation was injured by drought.

### TEMPERATURE.

The mean temperature was generally below the normal, the most marked deficiency being shown in the south Atlantic and Gulf states, and in Oregon and Washington, where it was more than 3°. In the middle and east Gulf states the month was exceptionally cool, and at points in that section the mean temperature was the lowest ever noted for July. A notable excess in temperature occurred only in the Lake Superior and Gulf of Saint Lawrence districts, where the mean was 2° to 3° above the July average. Light frost damaged vegetation about Carson City, Nev., on the 11th. Frost was reported in the Lehigh Valley, Pa., on the 18th. Vegetation about Havre, Mont., was touched by frost on the 28th.

### PRECIPITATION.

More than the usual amount of precipitation was reported in the east Gulf states, along the Virginia and south Atlantic coasts, and in the upper Mississippi and upper Missouri val-

leys. At points in the east Gulf states, the upper Mississippi valley, and North Dakota the monthly precipitation was the greatest ever reported for July. In New England, eastern Nebraska, eastern Kansas, and the Southwest there was a marked deficiency in precipitation. At points in New England, Pennsylvania, and the interior of Texas the monthly precipitation was the least ever noted for July.

### STORMS.

The occurrence of local storms was noted most frequently in Michigan and Iowa. The more destructive storms of the month occurred in Ohio, Indiana, Illinois, and Iowa on the 2d, a tornado being reported at Tocsin, Ind., and another near Davenport, Iowa; in Minnesota and North Dakota on the 11th; in Wisconsin on the 12th; in Ohio, Illinois, and North Dakota on the 13th, a tornado occurring at Springfield, Ohio; in South Dakota on the 19th, exceptionally heavy gales being reported, and a tornado occurring at Gettysburg, S. Dak.; in Illinois on the 20th; in North Dakota on the 22d; and in northern Ohio on the 24th.

### FLOODS.

The Mississippi River subsided slowly, and at the close of the month was above the danger-line at New Orleans, La., only. In the early part of the month some damage was caused about New Orleans by flood. Streams overflowed their banks in western Illinois. In Mississippi and Alabama high water in the Tombigbee, Warrior, Alabama, Coosa, and Pearl rivers caused considerable loss of property and crops.

### AUORAS.

The widely-observed and exceptionally brilliant auroral display of the 16th was an interesting and unusual feature of the month.

## ATMOSPHERIC PRESSURE (expressed in inches and hundredths).

The distribution of mean atmospheric pressure for July, 1892, as determined from observations taken daily at 8 a. m. and 8 p. m. (75th meridian time), is shown on Chart II by isobars.

In July the normal pressure is above 30.05 on the north

Pacific coast and over the east Gulf states and Florida. Over the west part of the southern plateau region the pressure is below 29.85, and along the extreme northern border of the country east of the 110th meridian the normal values are below 29.90. In July there is usually an increase of pressure, except in extreme northeast and northwest parts of the country,

the most marked increase occurring between the Mississippi River and the Rocky Mountains, where it exceeds .05.

In July, 1892, the mean pressure was highest over the Florida Peninsula and along the Georgia and South Carolina coasts, where it was above 30.15, and the mean readings were above 30.10 east of the Mississippi and south of the Ohio rivers and along the immediate north Pacific coast. The mean pressure was lowest in Saskatchewan and over the west part of the southern plateau region, where it fell to or below 29.80, and it was below 29.90 in the lower Saint Lawrence valley, over adjoining parts of Montana and the Dakotas, and over west parts of the middle and southern plateau regions.

A comparison of the pressure chart for July, 1892, with that of the preceding month shows a general increase of pressure, a slight decrease being shown only in the lower Saint Lawrence valley, in adjoining parts of Montana and North Dakota, in the middle Saskatchewan valley, and in the interior of Oregon and northern California. The greatest increase of mean pressure occurred over the southern lake region and thence to the Gulf coast and the southeast slope of the Rocky Mountains, where it was more than .10.

The mean pressure was above the normal, except over eastern Montana and the western Dakotas, where the mean values were slightly below the normal. The most marked departure above the normal pressure was noted in the middle and south Atlantic states, where it exceeded .10, and the departure above the normal was more than .05 east of the Mississippi River and along the Pacific coast north of the 40th parallel.

#### HIGH AND LOW AREAS.

The paths of areas of high and low pressure over the United States and Canada during July, 1892, are shown on Charts IV and I, respectively, and some of the prominent characteristics of the areas are given in the table at the end of this chapter.

#### HIGH AREAS.

Four high areas appeared, the average number traced for July during the last 18 years being 5.8. Two of the high areas of the current month advanced from the north Pacific Ocean, one first appeared over the western Saskatchewan valley, and one developed over the Lake region. The high areas from the north Pacific coast advanced south of east to the middle Atlantic states, from which region one passed to the Gulf of Saint Lawrence and the other recurred southward and westward over the Gulf of Mexico. The high area from the Saskatchewan Valley moved southeastward and disappeared by an increase of pressure over the middle Mississippi valley on the 31st. The high area from the Lake region moved southward along the Atlantic coast and thence westward over the Gulf of Mexico. The average velocity of the high areas was 24 miles per hour. The following is a description of the high areas traced:

I.—Occupied the north Pacific coast at the opening of the month, with pressure above 30.30. During the 2d this high area advanced south of east over the northern plateau region, and on the 3d reached the lower Missouri valley, attended by the lowest temperature of the month at points in the Dakotas and Minnesota. Moving eastward along the 40th parallel the center reached the Alleghany Mountains the evening of the 4th, with the lowest temperature of the month in West Virginia. By the morning of the 5th the high area had passed northeastward to New England, with pressure above 30.30, moved thence eastward off the New England coast, and the morning of the 6th had apparently reached the Gulf of Saint Lawrence. On the 5th the lowest temperature of the month was noted at points in northern New England.

Ia.—During the 5th high area I apparently divided, and at the evening report this high area was central north of Lake Erie where it remained nearly stationary until the morning of the 6th, with pressure rising to 30.50. The morning of the 7th the high area was central over New York, and during the day it shifted position southward over east Pennsylvania, and

on the 8th it passed southward to the Carolinas, where the lowest temperature of the month was noted. During the 9th and 10th the high area moved southward off the south Atlantic coast, and by the 11th had moved westward over the Florida Peninsula, with the lowest temperature of the month at Titusville, Fla.

II.—Advanced from the north Pacific coast, and the morning of the 14th was central over western Montana with pressure above 30.10. During the 15th the center advanced to Minnesota with pressure above 30.20, and during the 16th passed to the southern extremity of Lake Michigan. By the night of the 17th the high area had moved to the eastern Virginia coast, and the lowest temperature of the month occurred on that date at points in the lower lake region and along the New England and New Jersey coasts. Moving southward off the south Atlantic coast during the 18th, the center apparently passed westward and occupied the Gulf of Mexico by the morning of the 20th.

III.—Appeared over Alberta the morning of the 27th, with pressure above 30.20, and passed thence southeastward to the middle Missouri valley by the 29th. The night of the 29th this high area apparently divided, one part passing to the upper lake region, where it disappeared by a decrease of pressure after the 30th, the other moved southeastward over Missouri and Arkansas during the 30th and disappeared by a decrease of pressure over the lower Mississippi valley on the 31st.

#### LOW AREAS.

The low areas of July advance eastward over the United States at an average velocity of 25 miles per hour. The average velocity for May, June, and July being the lowest of the year. The storms of July generally appear on the middle and northeast slopes of the Rocky Mountains and pass over or north of the Lake region and Saint Lawrence Valley to Newfoundland. An average of less than one storm per month advances from the north Pacific coast and traverses the continent.

The tracks of 11 areas of low pressure are plotted on Chart I for July, 1892, the average number traced for July during the last 20 years being 9.5. The average velocity of the low areas was 30 miles per hour. Eight of the low areas first appeared in the Saskatchewan Valley, and 3 on the northeast slope of the Rocky Mountains. The storms from the Saskatchewan Valley generally moved eastward north of the Lake region and the Saint Lawrence Valley. One of these storms passed southeastward to the upper Mississippi valley and thence over the lower lake region and New England. Two of the storms from the northeast slope of the Rocky Mountains passed north of the Lake region and the Saint Lawrence River and moved southward along the eastern slope of the Rocky Mountains.

A description of the more important local storms that attended the low areas is given under "Local storms." The following is a description of the low areas of the month.

I.—Was central north of Montana at the opening of the month, with pressure below 29.50. By the evening report of the 1st the center had advanced to South Dakota, attended by brisk to high winds and rain in the Missouri Valley. During the 2d the storm-center advanced to northern Illinois; the rain area extended over the Ohio Valley and the Lake region, high winds occurred from the Missouri Valley over southern Lake Michigan, and thunderstorms occurred in the upper Mississippi valley. Moving rapidly eastward the center reached New Brunswick the night of the 3d, with pressure 29.50; rain fell generally from the Missouri and middle Mississippi valleys to the middle Atlantic and New England coasts, and high winds were reported in the lower lake region and along the Atlantic coast north of Hatteras, N. C. The morning report of the 4th showed this low area central over the Gulf of Saint Lawrence, with pressure below 29.50. On this date the weather was clearing in the middle Atlantic and New England states, and northwesterly gales occurred along the New England coast.

II.—On the 4th there was a marked decrease of pressure in the western Saskatchewan valley, and by the night of the 5th this low area was central north of Montana, with pressure below 29.50. The morning of the 6th the storm was central over eastern Montana, and passed thence to eastern Assiniboia by the night report, with rain in Montana, and high winds in the middle and upper Missouri valleys. During the 7th the center of disturbance advanced to Manitoba and passed thence northeastward beyond the region of observation. On that date the rain area extended over the Dakotas and eastern Colorado, and high winds were noted from Manitoba to Nebraska.

III.—Appeared over the western Saskatchewan valley the morning of the 9th and remained nearly stationary in that region until the night report, with pressure below 29.50, and rain over northern Montana. During the 10th the storm passed eastward and disappeared north of Manitoba without evidence of marked strength.

IV.—Apparently developed on the northeast slope of the Rocky Mountains and the morning of the 11th was central over southeastern Montana, with pressure below 29.70. By the evening report of the 11th the center had advanced to South Dakota, with pressure 29.60; rain fell over Montana and North Dakota, and high winds were noted in eastern Montana and the Dakotas. The morning report of the 12th showed this low area central north of Lake Superior, from which position it passed eastward to the region northeast of Georgian Bay by 8 p. m., with rain in the upper lake region, and high winds over eastern Lake Superior. During the 13th the center advanced north of the lower Saint Lawrence river, the rain area extended from the upper Ohio valley over the lower lake region and the interior of New England, and the weather was clearing in the upper lake region.

V.—Appeared over the western Saskatchewan valley on the 12th, with pressure below 29.70. The morning of the 13th a trough of low pressure extended from Assiniboia to northeast Utah, and low area Va developed over eastern Wyoming. On this date local storms occurred in the middle Missouri valley, and tornadoes were reported in the vicinity of North Platte, Nebr. The morning of the 14th the low areas had united over South Dakota, and the storm-center passed thence to the region north of Lake Superior by the evening report, with rain over the Dakotas and Minnesota, and high northwesterly winds over the Dakotas and Nebraska. The morning of the 15th the storm was central over eastern Upper Michigan, with pressure below 29.70. During the day it passed eastward to the region north of Lake Ontario, with pressure 29.50 and rain

and northwest gales over the Great Lakes, and thunderstorms in the lower lake region. The morning of the 16th the storm was central over the lower Saint Lawrence valley, with pressure below 29.40; rain fell in the middle Atlantic and New England states, and northwest gales occurred over the lower lakes. By the evening report of the 16th the storm had disappeared over the Gulf of Saint Lawrence.

VI.—Appeared over the western Saskatchewan valley on the 17th, with pressure below 29.50, and rain in areas in the Dakotas and Nebraska. During the 18th the center passed to the region north of Lake Superior, rain fell from the Missouri Valley over the western northern lake region, and heavy rains were reported in the Gulf States. By the night of the 19th the center had advanced to the lower Saint Lawrence valley, rain was followed by clearing weather in the Lake region, and fresh southwest winds prevailed over the lower lakes. During the 20th this low area disappeared north of the Gulf of Saint Lawrence.

VII.—Advanced eastward from Alberta, and the morning of the 20th was central north of North Dakota and a trough of low pressure extended thence to eastern Colorado. On this date thunderstorms occurred in the Missouri and upper Mississippi valleys, and thunderstorms were also reported on the south Atlantic coast. During the 21st the storm-center advanced eastward north of Lake Superior, and at the night report was central north of Georgian Bay. On that date thunderstorms occurred in the upper Mississippi valley. By the morning of the 22d the center of disturbance had reached the lower Saint Lawrence valley; on that date thunderstorms were reported in western New York in the afternoon.

VIII.—Advanced southeastward from Alberta, and the evening of the 22d was central north of eastern Montana, with pressure below 29.40. During the 23d the center passed eastward to the region north of Lake Superior and reached the lower Saint Lawrence valley by the night of the 24th, its passage being attended by thunderstorms and southwest gales in the lower lake region.

IX.—Appeared over the northern Saskatchewan valley the night of the 23d, with pressure below 29.40. During the 24th the center advanced to Manitoba, and during the 25th passed north of Lake Superior, with thunderstorms and heavy rain over the northern lake region. By the night of the 26th the center had reached the Gulf of Saint Lawrence, its passage being attended by thunderstorms in the lower lake region, the Ohio Valley, and Pennsylvania.

X.—Apparently advanced from the Saskatchewan Valley, and the evening of the 25th was central over eastern Montana,

Tabulated statement showing principal characteristics of areas of high and low pressure.

Barometer.	First observed.			Last observed.		Duration.	Velocity per hour.	Maximum pressure change in 12 hours, maximum abnormal temperature change in 12 hours, and maximum wind velocity.											
	Date.	Lat. N.	Long. W.	Lat. N.	Long. W.			Station.	Rise.	Date.	Station.	Fall.	Date.	Station.	Direction.	Miles per hour.	Date.		
High areas.		°	°	°	°	Days.	Miles.		Inch.										
I.....	2	47	125	49	61	4.0	39	Eastport, Me.....	.56	4	Miles City, Mont.....	24	1	Amarillo, Tex.....	n.	24	3		
II.....	5	43	82	28	82	5.5	15	Toronto, Ont.....	.16	6	Yarmouth, N. S.....	10	7	Kittyhawk, N.C.....	w.	44	10		
III.....	14	47	114	29	83	5.5	23	Rockliffe, Ont.....	.42	16	Father Point, Quebec.....	22	16	Fort Canby, Wash.....	s.	36	12		
Mean.....	27	46	113	36	88	4.0	21	Miles City, Mont.....	.40	27	Valentine, Nebr.....	22	27	Rapid City, S. Dak.....	nw.	26	29		
						4.8	24		.38			19				32			
Low areas.									Fall.			Rise.							
I.....	1	50	109	48	63	3.0	36	Concordia, Kans.....	.44	1	Eastport, Me.....	12	3	Kearney, Nebr*.....	se.	54	1		
II.....	5	51	110	52	101	2.0	19	Calgary, N. W. T.....	.34	4	Salt Lake City, Utah.....	17	4	Helena, Mont.....	sw.	54	4		
III.....	9	51	111	53	102	1.5	15	Miles City, Mont.....	.50	8	Swift Current, N. W. T.....	17	9	Winnemucca, Nev.....	sw.	36	9		
IV.....	11	45	107	50	68	2.0	42	Duluth, Minn.....	.24	11	Prince Arthur, Ont.....	17	11	Huron, S. Dak.....	nw.	48	12		
V.....	12	52	114	49	67	3.5	32	Kingston, Ont.....	.38	15	Pueblo, Colo.....	16	13	Detroit, Mich.....	nw.	44	15		
VI.....	17	58	114	50	70	2.5	33	Swift Current, N. W. T.....	.48	10	Spokane, Wash.....	18	17	Kittyhawk, N.C.....	sw.	44	15		
VII.....	20	53	103	51	69	2.0	32	Calgary, N. W. T.....	.40	19	Calgary, N. W. T.....	22	19	Huron, S. Dak.....	w.	50?	20		
VIII.....	22	52	107	50	62	2.0	44	do.....	.46	21	Rapid City, S. Dak.....	16	22	Cleveland, Ohio.....	nw.	64	24		
IX.....	23	54	106	51	63	3.0	26	Medicine Hat, N. W. T.....	.30	23	Rochester, N. Y.....	16	24	Huron, S. Dak.....	w.	56	25		
X.....	25	47	107	35	104	2.0	27	Huron, S. Dak.....	.20	24	Miles City, Mont.....	16	25	Denver, Colo.....	w.	48	26		
XI.....	28	51	114	50	81	3.0	20	Calgary, N. W. T.....	.38	28	Qu'Appelle, N. W. T.....	16	29	Pueblo, Colo.....	nw.	32	30		
Mean.....						2.4	30		.37			17				48			

\* W., 90, Mount Washington, N. H., 3d.

with pressure below 29.70. During the 26th the storm apparently divided, one part passing to Manitoba and the other to South Dakota. The morning of the 27th a trough of low pressure extended from Lake Superior to Colorado with 2 cyclonic centers, one north of Lake Superior and the other over Nebraska. On this date thunderstorms occurred in Nebraska, heavy rains were noted in Wisconsin and Ohio, and high westerly winds prevailed over the Lake region. By the night of the 27th the cyclonic area over Nebraska had been forced southward by an area of high pressure from the northwest and it apparently disappeared by an increase of pressure over western Texas and New Mexico. The storm central north of Lake Superior advanced to the region northeast of Georgian Bay by the night of the 28th, attended by thunderstorms in New York and the Ohio Valley, and heavy rain at points in the upper lake region. The storm remained

nearly stationary over the Saint Lawrence Valley during the 29th, with rain from the upper Mississippi valley over the middle Atlantic and New England states, and thunderstorms in New York state. By the morning of the 30th the center had disappeared over the Gulf of Saint Lawrence, rain continued in the middle Atlantic and New England states, and thunderstorms were reported in northern Virginia.

XI.—Appeared over Alberta the night of the 28th, with pressure 29.70, and during the 29th advanced eastward north of Montana, with pressure below 29.60, and rain and thunderstorms in the middle Rocky Mountain region. During the 30th the storm-center advanced eastward over Manitoba, without evidence of marked strength, and during the 31st passed to the region east of Lake Superior, with rain in the Atlantic coast states, and thunderstorms at points in the middle Atlantic coast states.

#### NORTH ATLANTIC STORMS FOR JULY, 1892 (pressure in inches and millimeters; wind-force by Beaufort scale).

The paths of storms that appeared over the west part of the north Atlantic Ocean during July, 1892, are shown on Chart I. These paths have been determined from reports of observations by shipmasters received through the co-operation of the Hydrographic Office, Navy Department, and the "New York Herald Weather Service."

In July there is usually an increase of pressure over the north Atlantic Ocean, except off the middle Atlantic and New England coasts and over eastern and extreme northern parts of the ocean. The increase of pressure is small, less than .05 inch, while from the British Isles northward the decrease is .05 to .10 inch.

The storms of July advance eastward over the north Atlantic at an average velocity of 19 statute miles per hour, and an average of 1.8 storm traverses the ocean from coast to coast. The principal track of July storms is traced from Newfoundland to a point west of Scotland, where it divides, one branch passing northeastward along the coast of Norway, one eastward over the North and Baltic seas, and one southeastward over Great Britain and France.

The storms of the current month were of small intensity, and no storms of tropical origin appeared within the region of observation. Four of the storms traced apparently advanced from the American to the European coasts. On the 3d a cyclonic depression moved eastward from the Labrador coast and reached mid-ocean on the 4th, with central pressure about 29.40 (747), and westerly gales of force 7 to 10. By the 5th this storm had advanced north of the British Isles, with pressure about 29.50 (749). During the 4th a storm of marked strength, low area I, moved east-northeast over the Gulf of Saint Lawrence, with pressure below 29.50 (749), and on the 5th was central north of the Banks of Newfoundland, with west to north gales of force 9 in the trans-Atlantic tracks between the 40th and 50th meridians. Moving north of east this storm passed north of the British Isles during the 8th, its passage being attended by strong northwest gales between the 20th and 30th meridians on the 6th.

On the 8th a storm apparently moved eastward from Labrador and reached mid-ocean on the 9th, with pressure about 29.50 (749), and westerly gales of force 9 to 10 between the 30th and 40th meridians. During the next 24 hours this storm increased in energy, and pressure below 29.40 (747) and northwest gales of force 10 were noted between the 20th and 30th meridians. During the 11th and 12th the storm-center remained nearly stationary west of Ireland, with northwest gales of force 9 to 10 east of the 20th meridian. By the 13th the center of disturbance had passed southeastward to the Bay of Biscay, and by the 14th had moved eastward over the continent of Europe.

On the 12th a storm appeared central north of the Banks of Newfoundland, and passed thence to mid-ocean, where pressure falling to about 29.70 and fresh gales were reported for the 13th and 14th. By the 16th the center of disturbance had

advanced south of Ireland, after which it disappeared to the eastward. During the 14th low area IV moved eastward over northern Newfoundland and occupied the region north of the Grand Banks on the 15th, after which the center apparently recurved westward and united with low area V. Low area V crossed the Gulf of Saint Lawrence and northern Newfoundland on the 17th, and passed thence rapidly northeastward beyond the region of observation. Low area VII moved eastward north of the Saint Lawrence River during the 22d, and the morning of the 23d was central over or near Labrador. This storm apparently remained stationary north of Newfoundland and the Grand Banks until the 27th, when it was joined by low area IX. During the next three days the pressure continued low over the western part of the ocean, with fresh south to west gales west of the 40th meridian. The month closed with high pressure and generally fine weather from coast to coast.

#### OCEAN ICE IN JULY.

The following table shows the southern and eastern limits of the region within which icebergs or field ice were reported for July during the last 10 years:

Southern limit.			Eastern limit.		
Month.	Lat. N.	Long. W.	Month.	Lat. N.	Long. W.
July, 1883.....	42 42	49 57	July, 1883.....	46 47	45 44
July, 1884.....	46 24	50 02	July, 1884.....	48 36	46 28
July, 1885.....	42 14	48 30	July, 1885.....	48 00	44 00
July, 1886.....	42 59	49 18	July, 1886.....	45 52	34 30
July, 1887.....	43 30	50 05	July, 1887.....	52 04	41 16
July, 1888.....	46 30	54 00	July, 1888.....	47 40	50 10
July, 1889.....	44 49	47 45	July, 1889.....	45 50	49 00
July, 1890.....	41 25	47 30	July, 1890.....	50 08	38 45
July, 1891.....	43 16	49 45	July, 1891.....	47 02	48 00
July, 1892.....	43 04	50 17	July, 1892.....	48 00	44 40
Mean.....	43 44	49 25	Mean.....	48 00	44 00

\*An iceberg and field ice. †On the 10th a small piece of ice was reported in N. 48° 33', W. 24° 11'.

The limits of the region within which icebergs or field ice were reported for July, 1892, are shown on Chart I by ruled shading.

The southernmost ice reported, an iceberg observed on the 28th in the position given, was about 1° south of the average southern limit, and the easternmost ice reported, a large iceberg noted on the 20th in the position given in the table, was nearly 1° west of the average eastern limit of Arctic ice for July. The ice of the current month was noted most frequently in and east of the Straits of Belle Isle and off the southeast coast of Newfoundland.

#### OCEAN FOG IN JULY.

The limits of fog belts west of the 45th meridian, as reported by shipmasters, are shown on Chart I by dotted shading.